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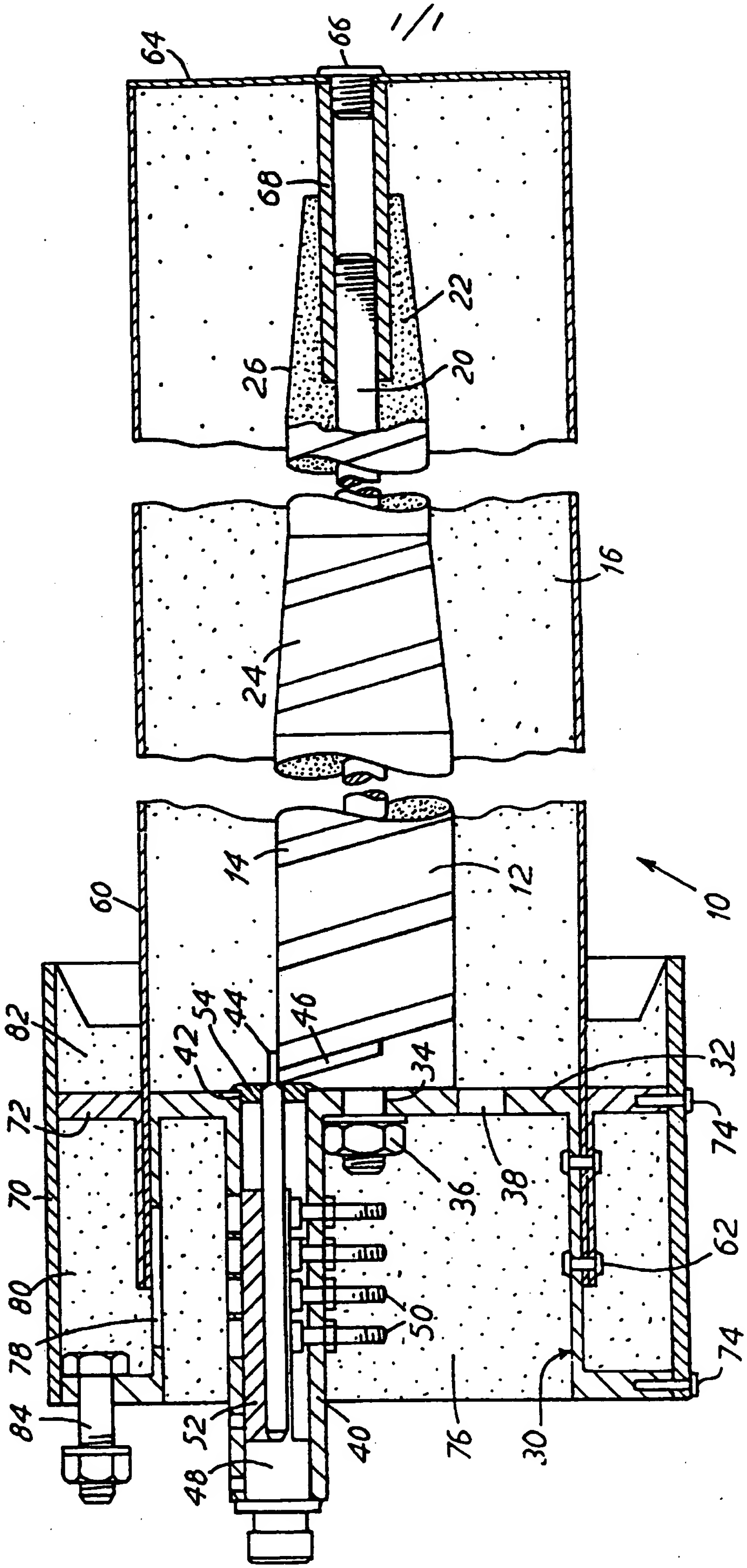
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Antenna Construction

This invention relates to antennas for use at UHF or microwave frequencies, and to methods of their manufacture.

There is a need for a reliable and weatherproof high-gain antenna for use above 1GHz and especially in the 2.3GHz band, such as for use by emergency services, which provides circularly polarised radiation. A conventional way of producing circular polarisation is with a helical antenna, comprising a helical or cork-screw shaped wire supported if necessary by spacers from a central supporting rod.

These have been very successful at frequencies of the order of 500MHz, but at frequencies above 1GHz their construction becomes more complex. For example to provide an effective beam at 2.3GHz requires of the order of 50 turns of the helix and supporting these turns becomes difficult. The support medium inside the turns has to be of sufficient strength and rigidity and thus becomes of sufficient bulk adversely to affect the radiation properties of the antenna. In particular, winding onto a fibreglass rod or tube would produce stray capacitance and unacceptable losses as a result.

The present invention provides an antenna construction of helical type for use at UHF frequencies, in which these problems can be substantially ameliorated.

The present invention in its various aspects is defined in the appended claims to which reference should now be made.

A preferred embodiment of the invention will now be described by way of example with reference to the drawing in which the sole figure shows a broken sectional view through a wideband helical antenna for use at frequencies of 1.8 to 2.3GHz.

The high-gain wideband antenna 10 illustrated is designed for use on either the 1.8 or 2.3GHz bands and provides circularly polarised radiation. The antenna has a central generally-cylindrical former 12 on which is wound in helical configuration a conductive copper tape 14. The assembly comprising the former and helical element is then surrounded by low-density foam 16, this

also being the major component of the former 12. In this way strength is given to the antenna by the foam both within and outside the helical element and thus it is not necessary to wind the helix on a strong former of high dielectric constant which would affect its radiation properties. Nevertheless the manufacturing operation is still relatively easy.

In more detail, the former 12 includes a solid central dielectric rod 20 but this is of small diameter compared to that of the former itself and is not of sufficient bulk materially to affect the radiation pattern. The rod 20 does not have to support the completed antenna in the field but serves primarily to give sufficient rigidity to the low density foam 22 in the former while the helical element is being wound upon it. The rod 20 is also threaded at its ends to enable the assembly to be attached to the feeder and to receive the end plate of an outer dielectric shield as described below. The rod can conveniently be made of a resin-bonded fabric material such as that sold under the trade mark Tufnol.

The performance of the antenna in terms of gain, frequency and bandwidth is critically dependent on the pitch and diameter of the winding on the former.

The former is of such diameter that its circumference is related to the wavelength of the radiation to be transmitted. Further information on the theory of helical antennae is to be found in Antenna Engineering Handbook, second edition, Johnson and Jasik, published by McGrawhill 1984. See especially Chapter 13. As this antenna is to operate over two principle bands the length of the former is divided into two parts of different diameters related to the two different frequency bands. The join between the two parts is provided by a tapering portion 24 to minimise unwanted reflections from the join. Likewise the end portion 26 of the former is tapered as shown.

In the illustrated example the former has a diameter of about 42mm in its wider part and 33mm in its narrower part and a length of about 2m.

At frequencies in the 1-10GHz range, it is convenient to make the radiating element in the form of a conducting strip or tape, as shown. This strip is also electrically effective for use as an

antenna since it has a low resistance. The adhesive copper tape 14 is very easy to wind on the former. In an alternative method however the former may be moulded with a grooved exterior to receive round wire.

When the helical element has been wound on the former the assembly is attached to the feeder. This comprises a cup-shaped metal housing 30 providing a circular end plate 32 for abutting the assembly and having a central hole 34 through which the rod 20 passes and where it is secured by a nut 36.

The feeder also includes a transmission line section 40 which extends from a hole 42 in the plate 32 adjacent the periphery of the former 12 and at its free end forms a socket 48 to receive a coaxial feeder cable (not shown). The section 40 includes a central conductor 44 the end of which is soldered to the end of the helical tape 14 which is provided with a widened portion 46 at this point.

In the side of the transmission line section 40 and within the housing 30 are provided four capacitative trimmers 50 which can be screwed in and out to provide the necessary impedance matching for the antenna. In the section 40 at this point part of the dielectic 52 is removed to allow for the trimmers 50.

Thus when the tape 14 is wound on the former 12, the assembly is attached to the feeder housing and the central conductor 44 of the feeder soldered to the tape 14.

Then a tubular dielectric cylinder 60 is fitted around the former extending over part of the housing 30 to which it is secured by rivets 62. The cylinder 60 can conveniently be made of fibreglass or ABS plastic. The volume within the dielectric cylinder 60 is now filled with low-density foam through a hole 38 in the base plate 32 thus surrounding and encapsulating the former 12 and helical element 14. The use of a large diameter cylinder surrounding the antenna and spaced well away from the antenna element reduces the dielectric losses introduced by the cylinder 60. This arrangement of the cylinder also increases the stiffness of the antenna. The end plate 64 of the cylinder is attached by means of a bolt 66 received in a sleeve 68 to the end of the rod 20. The bolt is secured by means of a small quantity of an adhesive such as an epoxy resin. During the foaming operation the foam is stopped from

passing into the transmission line section 40 by a grommet 54. It should be noted that the housing 30 is not filled with foam during this operation.

It should be noted that when the dielectric cylinder 60 is attached to the housing 30, an outer tubular member 70 is also attached which will provide a ground plane for the radiating structure. A flanged member 72 is fitted around the end of the dielectric cylinder 60 on the housing and secured by the rivets 62, and the tubular member 70 is attached to the flange of member 72 and a flange on housing 30 by suitable fasteners 74. The tubular member 70 extends beyond the base of the antenna element defined by the plate 32 to surround the end portion of the antenna assembly itself.

The trimmers 50 are now adjusted to provide the required impedance matching. When this has been completed, a second foaming operation takes place in which the body of the housing 30 is now filled with foam 76. This foam inhibits further movement of the trimmers 50 which extend into it so that there is no possibility of them losing their adjusted positions during use. Foam also passes through one or more holes 78 in the side wall of the housing 30 into the space within the tubular member 70. Foam 82 can also be provided within the part of the member 70 which extends over the end portion of the antenna element.

The antenna is now complete and can be secured to a mast by bolts such as bolt 84 passing through the flange on the housing 30.

The foam used can be any suitable low-density foam with a low dielectric constant which does not deleteriously affect the radiation properties of the helix. Suitable foams are polyurethane and polystyrene foam.

The resultant antenna is light and effective as much of the support for the structure is provided by the foam outside the helix and it is not therefore reliant on the whole support being supplied from inside the helix. The tubular portion of the dielectric sleeve 60 also assists in providing strength to the structure, as well as stopping damage by birds.

The antenna is a very effective way of providing a rigid support for a long pitch helical winding without seriously affecting the performance of the antenna. However, the construction described

here may also be used for short pitch helical windings if it is desired to keep the winding separated from any dielectric materials such as the fibre glass tube. The antenna is not limited to the 1.8GHz and 2.3GHz described in this specification.

CLAIMS

1. A method of making a helical antenna comprising the steps of providing a generally-cylindrical former made substantially of low-density foam, winding a conductor on the former in a helical configuration, and surrounding the resulting assembly with more low-density foam.

2. A method according to Claim 1, in which the step of surrounding the assembly with low-density foam comprises placing the assembly inside a dielectric tube and filling the tube with foam.

3. A method according to Claim 1 or 2, in which the former and the foam surrounding the assembly comprise the same low-density foam.

4. A method according to claim 1, 2 or 3, in which the former and the foam surrounding the assembly are formed of a polyurethane or polystyrene foam.

5. A method according to any preceding claim, in which the conductor comprises a self-adhesive copper tape.

6. A method according to any preceding claim, in which the former includes a central dielectric rod of diameter small compared to the diameter of the former.

7. A method according to any preceding claim, including the step of attaching a feeder to an end of the helical conductor, the feeder including one or more adjustable trimmers for impedance matching, adjusting the trimmers, and then surrounding at least part of the trimmers with foam to inhibit further movement thereof.

8. A method of making and matching an antenna substantially as herein described with reference to the drawing.

9. An antenna made by the method of any of the preceding claims.

10. A helical antenna comprising a generally-cylindrically central former made substantially of low-density foam, a helical conductor around the former, and additional low-density foam surrounding the former and conductor assembly to provide additional strength to the antenna.

11. A helical antenna according to claim 10 in which the low-density foam surrounding the former and conductor assembly is enclosed in a dielectric tube.

12. A helical antenna according to claims 10 or 11 in which the conductor is a self-adhesive copper tape.

13. A helical antenna according to claims 10, 11 or 12 in which the former includes a central dielectric rod of small diameter compared to the former.

14. A helical antenna according to claims 10 to 13 in which the end of the helical conductor is attached to a feeder, the feeder comprising one or more adjustable trimmers for impedance matching the trimmers being adjusted and at least partially surrounded with foam to prevent movement thereof.

15. A helical antenna substantially as herein described with reference to and as shown in the drawing.